Attorney Docket No.: 120399/11743 (21635-0057)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of: Roy Dean Meece et al.	)	Art Unit: 3722
Application No.: 10/071,596	)	Examiner: Cadugan
Filed: February 8, 2002	)	

For: METHOD OF CUTTING A HOLE IN A COMPOSITE MATERIAL WORKPIECE

APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant files its Appeal Brief in triplicate, together with a Fee Transmittal authorizing the charging of the required fee. A Notice of Appeal and fee were previously filed.

I. Real Party in Interest

The Real Party in Interest is the Assignee, the General Electric Co.

II. Related Appeals and Interferences

Applicant is not aware of any related appeals and/or interferences.

III. Status of Claims

Claims 1-19 were filed. During prosecution, claims 1, 5, 7, 12, and 16 were amended, and new claims 20-21 were added. Claims 1-21 are pending, all claims are finally rejected, and the rejections of all claims are appealed.

A clean copy of the appealed claims is set forth in the Claims Appendix.

IV. Status of Amendments

A Response to Final Rejection was filed, but it had no claim amendments.

V. Summary of Invention/Summary of Claimed Subject Matter

Composite materials are typically formed of fibers embedded into a matrix, wherein the individual phases retain their respective characters in the composite material. The cutting of a hole into a conventional metallic workpiece is a commonly performed machining operation. However, the cutting of holes in composite materials is often difficult for a number of reasons. Briefly, the difficulties arise due to the differences in the mechanical properties of the fibers and the matrix, the anisotropy of the structure, and the tendency of the material to splinter and fray on the sides of the drilled hole and at the front and back faces of the workpiece. The result of this damage is that the composite material with a drilled hole is susceptible to premature failure during service. See para. [0002]-[0004] of the application for more details.

In the present approach, see particularly claim 1, Figures 5-6, and para. [0028]-[0031] of the application, a milling cutter 50 is moved in an advance direction 70 parallel to its axis of rotation 52 and into the composite material workpiece 40. At the same time, the milling cutter is moved in a lateral direction 72 perpendicular to the advance direction 70 to remove material to define a periphery 74 of the hole 54 and the remainder of a surface 75 at the bottom of the hole 54, a process termed "interpolation". Because the diameter of the milling cutter 50 is less than the transverse size of the hole 54, such an interpolation process is necessary to machine the entire hole 54.

The rate of longitudinal advance is controlled such that the hole 54 has a substantially constant depth over its entire area as it is cut. That is, the hole 54 is substantially flat bottomed on the surface 75 as illustrated in Figure 6. This gradual removal of the material at the bottom of the hole 54 may be accomplished by holding the milling cutter 50 at a constant position relative to the advance direction 70 and moving it in the lateral directions 72 to define the periphery 74 of the hole 54.

This approach to removing the composite material to define the hole 54 advantageously acts upon only a very thin laminar region of the composite material when the periphery 74 of the hole 54 is being cut. The cutting forces and the distance over which they are applied to the composite material at the periphery 74 are small. This small force and small application distance reduce the tendency of the composite material at the periphery 74 to splinter, fray, and/or crack. The result is an excellent surface finish, with reduced tendency to splinter, fray, and/or crack, at an entrance point 78 where the milling cutter 50 first penetrates the front face 56 along what is eventually the hole periphery 74, along the sides 80 of the hole 54, and at an exit point 82 where the milling cutter 50 breaks through the back face 58 to define the periphery 74 of the hole 54 at the back face 58. The entrance point 78 and the exit point 82 are subject to such splintering, fraying, and/or cracking when conventional hole drilling techniques are used in relation to many composite materials, particularly the ceramic-matrix composite materials.

The invention further includes related methods of cutting holes in composite workpieces, as set forth in independent claims 12 and 20. Those claimed methods find their basis in para [0026-0031] of the specification. In particular, claim 12 is a method for cutting a hole of a hole size in a composite material workpiece, the method comprising the steps of: providing the composite material workpiece; selecting a milling cutter having an effective cutter size less than the hole size; mounting the composite material workpiece in operable relation to the milling cutter wherein the step of mounting includes the steps of providing a backing fixture, and affixing the composite material workpiece to the backing fixture with an adhesive material; rotating the milling cutter about an axis of rotation; advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole, the step of advancing including the step of controlling the rate of longitudinal advance such that the hole has a substantially constant depth over its entire area as it is cut; and, after the hole is completed, and removing the composite material workpiece from the backing fixture.

Claim 20 is a method for cutting a hole of a hole size in a composite material workpiece. That method comprises the steps of: providing a ceramic-matrix composite material workpiece having fibers embedded in a brittle ceramic matrix;

selecting a milling cutter having an effective cutter size less than the hole size; mounting the composite material workpiece in operable relation to the milling cutter wherein the step of mounting includes the steps of providing a backing fixture, and affixing a back face of the composite material workpiece to the backing fixture; rotating the milling cutter about an axis of rotation; and advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance from a front face of the composite material workpiece toward the back face, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole

VI. Grounds of Rejection to Be Reviewed on Appeal

The following issues concisely state the basis of the Examiner's rejection for all appealed claims, and clearly present the issues for appeal:

Issue 1. Are claims 1-19 and 21 properly rejected under 35 USC 112, first paragraph?

Issue 2. Are claims 1-21 properly rejected under 35 USC 112, second paragraph?

Issue 3. Are claims 1-3, 7-8, and 10 properly rejected under 35 USC 103 over any of Thelin US Patent 5,934,847, Thelin US Patent 5,816,755, Taquist US Patent 5,685,674, Eriksson US Patent 5,641,252, or WO 94/17944, in view of Tool and Manufacturing Engineers Handbook, Vol. 1, Machining, pages 10-50 through 10-61 and 12-144 (hereinafter "Handbook")?

Issue 4. Are claims 1-3 and 7-9 properly rejected under 35 USC 103 over either of Eriksson '252 or Eriksson US Patent 6,007,281, in view of Handbook, vol. 1, pages 10-50 through 10-61, and 12-144?

Issue 5. Is claim 4 properly rejected under 35 USC 103 over any of Thelin '847, Thelin '755, Taquist '674, Eriksson '281, Eriksson '252, or WO 94/17944, in view of Handbook, vol. 1, pages 10-50 through 10-61 and 12-144, and further in view of DE 19920365?

Issue 6. Are claims 4-6 properly rejected under 35 USC 103 as unpatentable over WO 94/17944 in view of Handbook, and further in view of Constantine US Patent 3,917,249?

Issue 7. Are claims 11-14 and 17-18 properly rejected under 35 USC 103 over either of Eriksson '252 or Eriksson '281, in view of DE '365 and further in view of Handbook?

Issue 8. Are claims 11-14, 17, and 19 properly rejected under 35 USC over any of Thelin '847, Thelin '755, Eriksson '252, Taquist '674, or WO 94/17944, in view of DE '365 and in view of Handbook?

Issue 9. Are claims 11-17 and 19 properly rejected under 35 USC 103 over WO '944 in view of Constantine '249 and in view of Handbook?

Issue 10. Is claim 20 properly rejected under 35 USC 103 over any of Thelin '847, Thelin '755, Taquist '674, Eriksson '252, or WO 94/17944, or Eriksson '281 in view of DE '365?

Issue 11. Is claim 21 properly rejected under 35 USC 103 over any of Thelin '847, Thelin '755, Eriksson '252, Taquist '674, Eriksson '252, or WO 94/17944, or Eriksson '281 in view of DE '365, and further in view of Handbook?

VI. Argument

Grouping of Claims for Argument

The claims do not stand or fall together, except as stated next.

Under Issue 1, claims 1-19 and 21 stand or fall together.

Under Issue 2, claims 1-19 and 21 stand or fall together as to the "flat bottom" point, and claims 12 and 20 stand or fall together as to the "brittle" point.

Under Issue 3, claim 8 stands or falls with claim 1.

Under Issue 4, claims 8-9 stand or fall with claim 1.

Under Issue 6, claim 6 stands or falls with claim 4.

Under Issue 7, claims 17-18 stand or fall with claim 11.

Under Issue 8, claim 18 stands or falls with claim 11.

Under Issue 9, claim 15-17 stand or fall with claim 11.

Arguments for separate patentability of the claims that do not stand or fall together are also presented.

Issue 1. Are claims 1-19 and 21 properly rejected under 35 USC 112, first paragraph?
Issue 2. Are claims 1-21 properly rejected under 35 USC 112, second paragraph?

These two rejections involve similar points, and they will therefore be addressed together. The thrust of these rejections is that there are two grounds of indefiniteness and inadequate disclosure:

(1) the recitation "maintaining the hole substantially flat bottomed as the milling cutter advances" (quoted from claim 1), or "the hole has a substantially constant depth" (quoted from claim 11).

(2) the recitation "brittle" in claims 12 and 20.

The limitation that the hole is "substantially flat bottomed" or "constant depth" is set forth in the context that the milling cutter has an effective cutter size less than the hole size. That is, the cross-sectional size of the hole is larger than the cross-sectional size of the milling cutter. One way to use a milling cutter in this circumstance would be to drill straight down to some depth, withdraw the milling cutter from the hole, move it laterally, then drill straight down again, and repeat this procedure as many times as necessary to form the larger hole, i.e., to form a large-diameter holes with a series of small-diameter holes. Another way to use it would be to drill straight down to the full depth of the material, and then move the milling cutter laterally to enlarge the hole, see para. [0032] of the present Specification and several of the applied patent references. That is not what happens in the present approach. As explained in detail in para. [0028]-[0030] of the present Specification, the milling cutter is used to cut a small distance longitudinally into the article and moved laterally to enlarge the hole to its full size; then the milling cutter is used to cut a further small distance longitudinally into the article and moved laterally to enlarge the hole to its full size; and so on. The longitudinal movement may be continuous or sequential, but the bottom of the hole remains substantially flat. Applicant took care to contrast this approach with approaches that are not within the scope of the invention, such as illustrated in Figure 7.

The explanation of the rejection states, at the top of page 3 of the final Office Action,

> "For example, note that in orbital machining of a hole in general, inherently either the tool has to be used to machine the hole at one depth, then advanced, then used to machine the hole at a slightly deeper depth, or the tool has to be constantly advancing while orbiting, thus producing a spiral tool path. In any case, Applicant has not specified either method, and neither method allows for the hole to be constantly flat-bottomed during the cutting process." [emphasis added]

This position is incorrect, because Applicant clearly stated how its hole-cutting process proceeds and what is within the scope of the language of the claims and what is not within the scope of the language of the claims.

In para. [0029] of the Specification, Applicant fully and carefully explains its terminology regarding a hole that is "substantially flat bottomed" or of "substantially constant depth":

> "The rate of longitudinal advance is controlled such that the hole 54 has a substantially constant depth over its entire area as it is cut in the step 28. That is, the hole 54 is substantially flat bottomed on the surface 75 as illustrated in Figure 6....This gradual removal of the material at the bottom of the hole 54 may be accomplished by holding the milling cutter 50 at a constant position relative to the advance direction 70 and moving it in the lateral directions 72 to define the periphery 74 of the hole 54. It may instead be accomplished by moving the milling cutter 50 relatively slowly in the advance direction 70 while moving it in the lateral direction 72 as well. In the description, the milling cutter 50 is described as moving relative to the stationary composite material workpiece 40, but the relative movement may instead be accomplished by a movement of the composite material workpiece 40 relative to milling cutter 50, or by a combination of the two movements." [emphasis added]

Thus, Applicant has clearly stated the nature of the hole-cutting process that is within the scope of the claim language.

Applicant distinguished alternative approaches that are not within the scope of the invention, see paragraph [0032]:

> "The present approach is to be contrasted with alternatives that are not within the scope of the invention, such as that illustrated in Figure 7. Here, a bit 90 is used to first drill entirely through a composite material workpiece 92 to define an initial through hole 94. If the hole is to be larger than the diameter of the bit 90, the bit 90 is thereafter moved laterally to create a larger hole 96. In this case, greater damage to the composite material at the periphery of either hole 94 or 96 is experienced, because the material removal forces applied at the periphery of the hole 94 or 96 are large and applied over a large distance at any moment."

The words that make up the phrases used in the claims are used in their conventional meanings. A "hole" is a "hollow place in a solid body or mass". The "bottom" is the "lowest or deepest part of anything, as distinguished from the top". "Flat" is "level, even, or without inequalities of surface" and "having a generally level shape or appearance". "Substantially" is the adverb corresponding to the meaning of "substantial", "of or pertaining to the essence of a thing" (i.e., essentially). All of these definitions come from Webster's Encyclopedic Unabridged Dictionary of the English Language. See also the body of the present application, such as para. [0029].

The explanation of the rejection and the Response to Arguments of the final Office Action is preoccupied with the meaning of "substantially" in "substantially flat". A search of the PTO database since 1975 shows that the term "substantially flat" appears in 53,099 issued patents (as of October 20, 2003). The term "substantially flat" appears in the claims of 22,992 issued patents (as of October 20, 2003). Applicant reviewed a sample of these 22,992 issued patents that use "substantially flat" in the claims, and in no cases reviewed by Applicant was the term "substantially flat" further defined in the patent. Two examples are US patents 4,772,376 and 6,633,643. Those skilled in the art understand this phraseology.

In short, the term "substantially flat" is widely used and well understood in the patent community and in the art, in the same context as the present claims. Those skilled in the art of cutting holes of a size larger than the cutter size in composite materials, as distinct from those wishing to concoct an attack on a clear disclosure on sec. 112 grounds in the absence of any substantial prior art, understand what this means and understand how to distinguish infringing from noninfringing behavior.

The phrase in claim 7, "controlling the rate of longitudinal advance such that the hole remains substantially a flat-bottomed hole as it is cut", means what it plainly says. The rate of longitudinal advance of the cutter into the workpiece maintains "substantially a flat-bottomed hole". The specific rate of advance to maintain the substantially flat-bottomed hole will depend upon the specific composite material being cut.

The Examiner's explanations of the sec. 112 rejections are full of hypotheses and arguments that have nothing to do with the present application. The speculation regarding what is "inherent" about orbital machining (final Office Action, page 3, line 2) and how cutting processes are performed (final Office Action, page 3, lines 1-15) are unrelated to the present application in which a hole is cut, and are not based on any reference of record dealing with hole cutting in composite materials. There is nothing "inherent" about Applicant's process in relation to the prior art, because it is absolutely unique. For example, the statement (final Office Action, page 3, lines 6-9) "Also, in general in machining of the type described by Applicant, tools are not used to remove large amounts of material at one time...[citing Tool and Manufacturing Engineers Handbook]" has no relevance to the present discussion. As will be discussed further below, Tool and Manufacturing Engineers Handbook has nothing to do with the cutting of holes, with the processing of composite materials, with the cutting of holes in composite materials, or with the cutting of holes in which the cutter is smaller than the hole. None of the references that are currently of record describes "machining of the type described by Applicant". If they did, the prior art rejections would be sec. 102 rejections, not sec. 103 rejections. Accordingly, there is no relation of the reference to the present claims. Applicant did its best to understand what this rejection is about and to respond, but requested clarification of what is meant by "machining of the type described by Applicant" as related to any of the references,

because none of the references relates at all to "machining of the type described by Applicant". No further explanation was forthcoming.

The discussion at pages 22-25 of the final Office Action has superficially addressed Applicant's remarks without addressing the substance. It is stated (final Office Action, page 22, line 23) that "...the hole still does not remain 'flat'". Yes, it does, because Applicant fully explained what is to be considered to be within the language a "flat-bottomed hole" as quoted above.

Regarding the use of "substantially flat" in other patents, the use is in exactly the same context as the present claims, specifically in relation to the description or character of a surface, and more specifically the degree of flatness or unflatness of a surface. Applicant did not address questions of the use of "substantially" in other contexts, such as "substantially smaller" (as in Eriksson '252, col. 5, line 7) or "substantially orthogonal" (as in Eriksson '281, col. 8, line 63) or anything else. (Neither of these uses of "substantially" is defined in the specification of the respective Eriksson patents.) Applicant specifically addressed "substantially flat", the objected-to claim terminology. There has been no substantive response to this point.

The explanation of the rejection and the Response to Arguments, to the extent that they may be understood, are preoccupied with arguing that there is no quantitative definition of "substantially flat" in the application. That was not the intent of the present application or the present claims, which qualitatively compares "substantially flat" with other ways of producing holes. The vast majority of usages of adjectives such as "flat" in the conventional technical usage of those skilled in the art and in patents relates to distinguishing "substantially flat" from something else, such as "substantially curved". That is the context in which the present application uses "substantially flat", and in which the patents cited by Applicant use "substantially flat".

In arguing the sec. 112 rejections, the Examiner has refused to substantively addressed the points of para. [0028]-[0032] of the Specification, in which there is a clear, straightforward explanation to those skilled in the art of cutting holes in composite materials as to how to practice the present approach and how to tell if what they are doing falls within the scope of the present claims.

There is a further sec. 112 rejection asserting that "brittle" as used in claims 12 and 20 is indefinite. Webster's Encyclopedic Unabridged Dictionary defines brittle as

"having hardness and rigidity but little tensile strength; breaking readily with a comparatively smooth fracture, as glass." That is how "brittle" is used in the present application and in the present claims, and the definition of "brittle" is thus clear and definite.

Issue 3. Are claims 1-3, 7-8, and 10 properly rejected under 35 USC 103(a) as being unpatentable over any of Thelin US Patent 5,934,847, Thelin US Patent 5,816,755, Taquist US Patent 5,685,674, Eriksson US Patent 5,641,252, or WO 94/17944, in view of Tool and Manufacturing Engineers Handbook, Vol. 1, Machining, pages 10-50 through 10-61 and 12-144 (hereinafter "Handbook")?

The statement of the rejection cannot be understood, as it is unclear whether the rejection seeks to combine exactly one or more than one of Thelin US Patent 5,934,847, Thelin US Patent 5,816,755, Taquist US Patent 5,685,674, Eriksson US Patent 5,641,252, and WO 94/17944, in combination with Handbook. The explanation of the rejection gives no clues as to how the rejection is to be constructed from the six references. Applicant will do its best to respond.

Further, the substance of the rejection cannot be understood, inasmuch as the relied-upon teachings of DE '365 are not set forth in a translation of the reference. There is reliance on some English-language partial narrative description, which may not set forth the substance of DE '365. No effective date as a reference of the partial narrative description is provided, so Applicant does not know if the partial narrative description is an effective reference.

The first point to be addressed here, and which is relevant to other issues, is that the secondary "Handbook" reference may not be properly applied in a sec. 103 rejection of the present claims. Handbook is clearly nonanalogous art. Stated alternatively, Handbook is not within the scope and content of the prior art that may be used in forming a sec. 103 rejection. Its teachings are therefore not properly combined with the teachings of any of the five patent references. To be analogous art and properly used in forming a sec. 103 rejection, a reference must be concerned with the same problem as another reference and the claims which are being addressed. See, for example, Medtronic, Inc. v. Cardiac Pacemaker, Inc., 220 USPQ 97, 104 (Fed. Cir. 1983), stating: "Faced with a rate-limiting problem, one of ordinary skill in

the art would look to the solutions of others faced with rate-limiting problems." In the present case, the inventor was concerned with a problem in cutting holes in composite materials. See the Background section of the Specification, the balance of the Specification, and all of the claims. Handbook has nothing to do with the cutting of holes, with the processing of composite materials, with the cutting of holes in composite materials, or with the cutting of holes in which the cutter is smaller than the hole, and therefore is not properly within the scope of the prior art. It is therefore not properly applied in rejecting the present claims.

Handbook deals with the conventional milling of metals (see tables 10-5, 10-7, 10-8, and 12-56, for example) and not with the cutting of holes or composite materials. Composite materials have different materials properties that lead to different behavior in hole-cutting operations, see the discussion at para. [0004]-[0005] of the present Specification, as well as the discussions in any of Thelin '847, Thelin '755, Taquist '674, Eriksson '281, Eriksson '252, and WO 94/17944. For example, Taquist '674 states at col. 1, line 49-56: "The methods used to produce holes in composite laminates are the traditional....Also, newer methods such as .... are being used. The problem associated with these hole-forming methods as they are applied at the present time is that they are not sufficiently effective for various reasons from a technical/economic point of view." Handbook offers prime examples of the "traditional" approaches used in milling (not even hole forming), and there is no reason to believe that they are applicable to the cutting of holes in composite materials. There is no teaching in the Handbook that would relate to the technique to be used in the cutting of holes, or to composite materials, or to the cutting of holes in composite materials.

As Applicant notes in paragraph [0021] of the Specification, "The brittle ceramic matrix 44 of such composite materials is highly susceptible to damage and failure by splintering, fraying, and/or cracking when conventional hole-drilling techniques are used." Handbook discusses only such "conventional hole-drilling techniques" in metals, and not the present problem at all.

Nor does the Handbook deal with drilling a hole or drilling a hole that has a larger cross sectional than the milling cutter. The Handbook has nothing to teach regarding this type of hole cutting as recited in the present claims, a key point that will be discussed in greater detail subsequently.

In the Response to Arguments at page 27, line 12 et seq. of the final Office Action, there is an attempt to argue that somehow some of the discussion of Handbook can be used even though it is admitted that it does not deal with the drilling of holes or with composite materials. There is an attempt to suggest that Handbook relates to something other than metals: "...particular materials, some of which are metal..." (final Office Action, page 27, line 15). In fact, every one of the materials discussed by Handbook as being milled is a metal. If the Examiner takes a contrary position, the precise location of the discussion of composite materials in Handbook must be set forth. Otherwise, the attempt to mislead the discussion by language such as "some of which are metal" must be discontinued. The discussion of Handbook relates only to metals, not composite materials such as set forth in the patent references, and it does not relate to the cutting of holes. The attempt to apply this reference to situations to which there was never any contemplation of its application by its authors is a per se hindsight forbidden reconstruction.

Applicant next turns to the discussion of the specific claim limitations.

The following principle of law applies to all sec. 103 rejections. MPEP 2143.03 provides "To establish prima facie obviousness of a claimed invention, all claim limitations must be taught or suggested by the prior art. In re Royka, 490 F2d 981, 180 USPQ 580 (CCPA 1974). All words in a claim must be considered in judging the patentability of that claim against the prior art. In re Wilson, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)." [emphasis added] That is, to have any expectation of rejecting the claims over a single reference or a combination of references, each limitation must be taught somewhere in the applied prior art. If limitations are not found in any of the applied prior art, the rejection cannot stand. In this case, the single applied prior art reference clearly does not arguably teach some limitations of the claims.

Claim 1 recites in part:

> "advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance, while laterally moving the milling cutter

perpendicular to the axis of rotation to interpolate the hole, and while maintaining the hole substantially flat bottomed as the milling cutter advances"

The five patent references each discloses an approach for producing a hole in a composite material that is admittedly different from the present approach. Otherwise, the rejection would have been a sec. 102 rejection, an approach attempted in the first Office Action and now withdrawn.

The five patent references are interesting in that they do not teach the present approach, and in most cases teach directly away from the present approach.

Thelin '847 and Thelin '755 each teaches directly away from the present approach, by teaching that the through-hole is drilled first, and then the cutter is inserted and moved laterally, see Figures 2A-B.

Taquist '647 teaches creating a hole through the composite material, then producing an eccentric motion that laterally enlarges the hole, see col. 2, lines 56-63.

Eriksson '252 uses a simultaneous axial and radial machining, see col. 5, lines 13-15, but has no teaching of how these movements are coordinated.

WO '944 describes an apparatus that allows the drilling of holes in a piece of composite material, but never does say how the hole is drilled. Specifically, there is no teaching regarding whether a through-hole is first drilled, as in Thelin '847, Thelin '755, and Taquist '647, or whether some other technique is used.

The explanation of the rejection does not address these specific teachings of the five patent references. That is, the explanation of the rejection does not indicate that three of the references (Thelin '847, Thelin '755, and Taquist '647) teach directly away from the present approach, Eriksson '252 is silent on its approach, and WO '944 teaches only the hole-cutting machine structure with no teaching about how the machine is actually used to cut a hole.

The explanation of the rejection admits that the patent references do not teach the claim limitations (final Office Action, page 5, lines 1-7): "...each of the...references...is silent as to the particular rate of longitudinal advance of the cutter [and]...whether the hole remains 'substantially flat-bottomed"...". There is an attempt to find these limitations in Handbook. This attempt fails for several reasons.

First, as noted above, Handbook is nonanalogous art that does not deal with "cutting a hole" or with a "composite material workpiece" at all. Applicant explained in the Specification why a "composite material workpiece" has its own special problems in regard to hole cutting, and every one of the five patent references agrees with Applicant. The Examiner has not shown that the Handbook addresses problems or has any relevant teachings to the present problem of hole cutting in composite materials, or the problems addressed by the five patent references, at all.

Second, the explanation of the rejection does not point to any location in Handbook that deals with a composite material. Claim 1 recites in part: "providing the composite material workpiece". Handbook does not have any teaching about a composite material workpiece.

Third, the explanation of the rejection never is able to point to a location in Handbook where Handbook has any teaching about a situation of "the milling cutter having an effective cutter size less than the hole size", as recited in claim 1. Handbook is concerned with the simple problem of milling a workpiece by lateral movement of the milling cutter (see Fig. 10-78). That is a completely different problem than drilling an oversize hole. The explanation of the rejection argues that simple lateral milling makes obvious the claim limitation "maintaining the hole substantially flat bottomed as the milling cutter advances", when of course Handbook has nothing to do with the type of problem that the claim addresses, where the size of the cutter is less than the hole size. The discussion of Handbook's alleged teachings found at page 5, lines 8-17 of the final Office Action is at attempt to draw general inferences about a completely different problem and completely different material from an unrelated reference. Handbook does not discuss the cutting of holes at all. In Handbook, there is no hole to remain substantially flat-bottomed, because the milling cutter is simply moved laterally in the referenced portion of Chapter 10.

Fourth, for all of the argument, there is never any showing of a teaching in any of the references of the limitation "maintaining the hole substantially flat bottomed as the milling cutter advances" from claim 1.

Fifth, the discussion at page 12-114 of Handbook deals with thread milling and has no relation at all to hole drilling, even though this page is a central basis of the rejection. Applicant still cannot figure out any relevance of Chapter 12 of

Handbook, dealing with thread milling, might be, and there is no explanation in the final Office Action.

Claim 2 recites in part:

"providing a ceramic matrix composite material workpiece"

Claim 3 recites in part:

"providing a silicon carbide/silicon carbide composite material workpiece"

Neither reference has any such teaching. Regarding claims 2-3, the explanation of the rejection makes the incredible statement, "Applicant has not ascribed any particular criticality to the use of a 'ceramic matrix composite..." Applicant certainly did so. Applicant notes in paragraph [0021] of the Specification, "The composite material workpiece may be of any operable type, but it is preferably a ceramic-matrix composite material wherein the matrix 44 is a nonmetallic, nonorganic, ceramic phase. The brittle ceramic matrix 44 of such composite materials is highly susceptible to damage and failure by splintering, fraying, and/or cracking when conventional hole-drilling techniques are used." While composite materials pose difficult hole-forming problems, the ceramic-matrix composite material poses the greatest difficulty because of its brittle matrix. The present approach provides the solution for this difficult problem. Handbook, for example, does not even deal with this problem. The references have no teaching of the limitations of claims 2-3.

The attempt at rationalizing this limitation is then argued to be based in "design choice". The concept of "matter of obvious design choice" is not intended to substitute for statutory prior art. It provides a means by which one of several realistic alternatives presented by statutory prior art may be selected, absent surprising or unexpected advantages. It is to be used only where the applied statutory prior art sets forth a list of realistic alternative selections, and it would be a matter of design choice to select one member from the list. In this case, the prior art of record presents no such design choice, and accordingly the application of "obvious matter of design choice" is not appropriate here.

Claim 7 recites in part:

"controlling the rate of longitudinal advance such that the hole remains substantially a flat-bottomed hole as it is cut."

None of the references has any such teaching, and most teach away from this limitation, while the others are silent. The explanation of the rejection admitted (see above) that the art does not teach such a limitation.

Claim 10 recites in part:

"advancing the milling cutter longitudinally into the composite material workpiece by at least a thickness of the composite material workpiece, thereby forming a through hole"

None of the references has any such teaching, in the context of the present claim 1, which has the "flat bottomed" limitation. Some references push the cutting tool all the way through the workpiece, but not in the manner of the present approach.

The present rejection seeks to perform a hindsight reconstruction based upon unrelated references, which is technically unsupported and is legally improper, and in any event do not teach important claim limitations.. The case authority and the MPEP provide guidance on this point. The present rejection is a sec. 103 combination rejection. It is well established that a proper sec. 103 combination rejection requires more than just finding in the references the elements recited in the claim (but which was not done here). To reach a proper teaching of an article or process through a combination of references, there must be stated an objective motivation to combine the teachings of the references, not a hindsight rationalization in light of the disclosure of the specification being examined. MPEP 2143 and 2143.01. See also, for example, In re Fine, 5 USPQ2d 1596, 1598 (at headnote 1) (Fed.Cir. 1988), In re Laskowski, 10 USPQ2d 1397, 1398 (Fed.Cir. 1989), W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 311-313 (Fed. Cir., 1983), and Ex parte Levengood, 28 USPQ2d 1300 (Board of Appeals and Interferences, 1993); Ex parte Chicago Rawhide Manufacturing Co., 223 USPQ 351 (Board of Appeals 1984). As stated in In re Fine at 5 USPQ2d 1598:

> "The PTO has the burden under section 103 to establish a prima facie case of obviousness. [citation omitted] It can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references."

And, at 5 USPQ2d 1600:

> "One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention."

Following this authority, the MPEP states that the examiner must provide such an objective basis for combining the teachings of the applied prior art. In constructing such rejections, MPEP 2143.01 provides specific instructions as to what must be shown in order to extract specific teachings from the individual references:

> "Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention when there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. In re Fine, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); In re Jones, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992)."
>
> * * * * *
>
> "The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990)."
>
> * * * * *
>
> "A statement that modifications of the prior art to meet the claimed invention would have been 'well within the ordinary skill of the art at the time the claimed invention was made' because the

> references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references. Ex parte Levengood, 28 USPQ2d 1300 (Bd.Pat.App.& Inter. 1993)."

Here, there is set forth no objective basis for combining the teachings of the references in the manner used by this rejection, and selecting the helpful portions from each reference while ignoring the unhelpful portions. The six primary references deal with composite materials, and Handbook deals with metals. An objective basis is one set forth in the art or which can be established by a declaration, not one that can be developed in light of the present disclosure. Applicant repeatedly asked that the Examiner set forth the objective basis found in the references themselves for combining the teachings of the references, and specifically an objective basis why the teachings of Handbook concerning milling of metals in which no holes are cut should be considered as relevant to cutting holes in composite materials. If the conventional milling of metals is pertinent to the cutting of holes in composite materials, there should be a reference that says so. The Examiner never responded.

Issue 4. Are claims 1-3 and 7-9 properly rejected under 35 USC 103 over either of Eriksson '252 or Eriksson US Patent 6,007,281, in view of Handbook, vol. 1, pages 10-50 through 10-61, and 12-144?

The statement of the rejection of Issue 4 is confusing and apparently repetitive with the statement of the rejection of Issue 3. One construction of the rejection of Issue 3 is Eriksson '252 in view of Handbook, and one construction of the rejection of Issue 4 is also Eriksson '252 in view of Handbook. There is no explanation as to whether the same rejection is being stated twice, or whether two different rejections are intended. Applicant has responded to the extent that it can do so.

The prior discussion of Eriksson '252 and Handbook is incorporated here, and the prior discussion of Issue 3 is incorporated here.

Eriksson '281 has a disclosure similar to that of Eriksson '252 in relevant aspects, except that it clearly teaches the use of a hole that does not have a flat bottom, see Figure 16 and the associated discussion.

Each Eriksson patent explicitly teaches "simultaneous machining the workpiece in both an axial and a radial direction..." (Eriksson '252 at col. 5, line 13 and Eriksson ' 281 at col. 8, lines 65-66. This is not a teaching that the hole is or could be flat bottomed.

The explanation of the rejection asserts that Eriksson '252 and '281 teach "orbital machining", making reference to portions of the teachings of the Eriksson inventions. Eriksson never uses the term "orbital machining" to refer to his own invention. The only mention of "orbital machining" in these references occurs in a discussion of a prior art Swedish patent, see col. 2, line 48 of '252 and col. 3, line 1 of '281. This is an important point, because a conclusion of "orbital machining" has significant consequences that are not taught in either Eriksson reference. Any assertion of "orbital machining" in relation to Eriksson's teachings is pure Examiner's speculation unsupported in the references.

What is clear in both references is that there is no teaching remotely similar to the claim recitation "maintaining the hole substantially flat bottomed as the milling cutter advances" of claim 1. There is only a teaching of simultaneous machining in two directions.

Handbook, as noted earlier, is nonanalogous art that does not have any teachings on point to composite materials or to the machining of a hole that is larger than the cutter size. Handbook deals only with thread milling and lateral milling, but not to hole cutting. The explanation of the rejection is not able to point to any portion of Handbook that teaches "maintaining the hole substantially flat bottomed as the milling cutter advances".

Claim 2 recites in part:

"providing a ceramic matrix composite material workpiece"

Claim 3 recites in part:

"providing a silicon carbide/silicon carbide composite material workpiece"

Neither reference has any such teaching. Regarding claims 2-3, the explanation of the rejection makes the incredible statement, "Applicant has not ascribed any particular criticality to the use of a 'ceramic matrix composite..." Applicant certainly did so. Applicant notes in paragraph [0021] of the Specification, "The composite material workpiece may be of any operable type, but it is preferably a ceramic-matrix composite material wherein the matrix 44 is a nonmetallic, nonorganic, ceramic phase. The brittle ceramic matrix 44 of such composite materials is highly susceptible to damage and failure by splintering, fraying, and/or cracking when conventional hole-drilling techniques are used." While composite materials pose difficult hole-forming problems, the ceramic-matrix composite material poses the greatest difficulty because of its brittle matrix. The present approach provides the solution for this difficult problem. Handbook, for example, does not even deal with this problem. The references have no teaching of the limitations of claims 2-3.

The attempt at rationalizing this limitation is then argued to be based in "design choice". The concept of "matter of obvious design choice" is not intended to substitute for statutory prior art. It provides a means by which one of several realistic alternatives presented by statutory prior art may be selected, absent surprising or unexpected advantages. It is to be used only where the applied statutory prior art sets forth a list of realistic alternative selections, and it would be a matter of design choice to select one member from the list. In this case, the prior art of record presents no such design choice, and accordingly the application of "obvious matter of design choice" is not appropriate here.

Claim 7 recites in part:

> "controlling the rate of longitudinal advance such that the hole remains substantially a flat-bottomed hole as it is cut."

None of the references has any such teaching, and most teach away from this limitation, while the others are silent. The explanation of the rejection admitted (see above) that the art does not teach such a limitation.

Applicant incorporates the prior discussion regarding the need for an objective basis for combining the teachings of the references.

Applicant asks that the Examiner reconsider and withdraw this ground of rejection.

Issue 5. Is claim 4 properly rejected under 35 USC 103 over any of Thelin '847, Thelin '755, Taquist '674, Eriksson '281, Eriksson '252, or WO 94/17944, in view of Handbook, vol. 1, pages 10-50 through 10-61 and 12-144, and further in view of DE 19920365?

The statement of the rejection cannot be understood, as it is unclear whether the rejection seeks to combine exactly one or more than one of Thelin '847, Thelin '755, Taquist '674, Eriksson '252, Eriksson '252, and WO 94/17944, in combination with Handbook. The explanation of the rejection gives no clues as to how the rejection is to be constructed from the seven references. Applicant will do its best to respond.

Further, the substance of the rejection cannot be understood, inasmuch as the relied-upon teachings of DE '365 are not set forth in a translation of the reference. There is reliance on some English-language partial narrative description, which may not set forth the substance of DE '365. No effective date as a reference of the partial narrative description is provided, so Applicant does not know if the partial narrative description is an effective reference.

Applicant incorporates its prior discussion of Issues 3 and 4.

All of the references except DE '365 have been discussed previously, and the prior discussion is incorporated by reference.

DE '365 is in German, and Applicant does not read or speak German at the level required to understand the reference. Some partial narrative description of DE '365 is provided, but there is no verbatim translation. In view of the significance of this reference, Applicant was unable to fully respond to this ground of rejection due to the absence of a full verbatim translation of the reference. Applicant therefore asked that the Examiner provide a full verbatim translation of the DE '365 reference, if it were to be relied upon further, and to issue a new nonfinal office action that included the translated reference so that Applicant could fairly understand and respond to the rejection. As it is now, neither Applicant nor the Board can tell if DE '365 relates to composite materials, or to the flat-bottomed hole-cutting technology to which claim 4

relates. The rejection is misstated because it is in fact based on some stray narrative of uncertain origin and accuracy, not on the reference or a translation of the reference.

At page 26, lines 15-16 of the final Office Action, the Response to Arguments asserts that it is permissible to violate the legal requirements and the MPEP that mandate that a reference must be considered for the entirety of its teachings, not for some isolated, piecemeal point. The selective use of only the helpful teachings of a reference, and not giving weight to the overall teachings of the reference, in this manner is a per se hindsight reconstruction. This approach is not proper. In In re Mercer, 185 USPQ 774, 778 (CCPA 1975), the CCPA stated:

> "The relevant portions of a reference include not only those teachings which would suggest particular aspects of an invention to one having ordinary skill in the art, but also those teachings which would lead such a person away from the claimed invention. See In re Lunsford, 53 CCPA 986, 357 F.2d 380, 148 USPQ 716 (1966)."
>
> "The Board's approach amounts in substance, to nothing more than a hindsight 'reconstruction' of the claimed invention by relying on isolated teachings of the prior art without considering the over-all context within which those teachings are presented. Without the benefit of appellant's disclosure, a person having ordinary skill in the art would not know what portions of the disclosure of the reference to consider and what portions to disregard as irrelevant, or misleading. See In re Wesslau, 53 CCPA 746, 353 F.2d 238, 147 USPQ 391 (1965)."

Regardless of the Examiner's contentions to the contrary, the entirety of the reference is pertinent. If it is relied upon in forming a rejection, a translation must be provided so that Applicant and the Board may assess the entirety of the teachings. For example, the relied-upon English-language material does not state whether the workpiece is a composite material, or whether holes are being drilled in the workpiece that are larger than the cutting tool.

The discussion of "arguments against the references individually" (final Office Action page 26, line 10) is a straw man. Applicant was not arguing against the DE

'365 reference individually, because in fact Applicant cannot read the reference and cannot determine what it says. No prima facie case of obviousness is made, because a prima facie case of obviousness requires use of the entire teachings of the reference and requires the showing of an objective basis for combining the teachings of the references, neither of which requirements is met by the present rejection.

So for the moment Applicant cannot respond further to this rejection in view of the Examiner's refusal to follow the rules and provide Applicant a copy of the entirety of the relied-upon reference.

Claim 4 incorporates the limitations of claim 1. The prior discussion of the rejection of claim 1 is incorporated here. Unless DE '365 discusses maintaining a flat-bottom hole in a composite material, this combination of references does not teach the present approach.

Applicant asks that the Examiner reconsider and withdraw this ground of rejection.

Issue 6. Are claims 4-6 properly rejected under 35 USC 103 as unpatentable over WO 94/17944 in view of Handbook, and further in view of Constantine US Patent 3,917,249?

The prior discussion of Issues 3-5 is incorporated here.

Claims 4-6 depend from claim 1, whose limitations are not taught by these references. Specifically, none of these references teach the limitations of claim 1,

> "advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole, and while maintaining the hole substantially flat bottomed as the milling cutter advances"

The WO '944 and Handbook references have been discussed previously, and the prior discussion is incorporated here. WO '944 teaches a device in which the tool holder 4 and thence the cutting tool may be moved longitudinally to deepen the hole,

and laterally to widen the hole. There is no discussion of how these two movements are coordinated, if at all. For example, there is no teaching that the hole is not to be drilled by first drilling down to a selected depth by longitudinal movement of the tool holder 4, and then to move laterally to widen the hole. During prosecution, Applicant asked that, if the Examiner contended that this limitation is taught by WO '944, its location in the reference be stated with specificity. There was no response. Certainly WO '944 discusses some control capabilities of its device, but Applicant finds no teaching of the recited claim limitations. The above limitation of claim 1 is not taught by Handbook, because Handbook has no teaching of hole drilling or composite materials.

The above limitation of claim 1 is also not taught by Constantine '249, as it does not relate to composite materials or to the drilling of holes in composite materials, or to the affixing of a composite material workpiece to a backing fixture, or to the affixing of a composite material workpiece to a backing fixture as part of a process in which a hole is drilled. Accordingly, it is nonanalogous art for the legal reasons discussed earlier, and which are incorporated here.

Claim 4 recites in part:

> "affixing the composite material workpiece to the backing fixture with an adhesive material"

None of the references teach affixing a composite material in any fashion, whether to a backing fixture or anything else, with an adhesive material.

Claim 5 recites in part:

> "affixing the composite material workpiece to the backing fixture with a thermoplastic adhesive material".

None of the references teach affixing a composite material in any fashion, whether to a backing fixture or anything else, with a thermoplastic adhesive material.

Issue 7. Are claims 11-14 and 17-18 properly rejected under 35 USC 103 over either of Eriksson '252 or Eriksson '281, in view of DE '365 and further in view of Handbook?

All of these references have been discussed previously, and that discussion is incorporated herein by reference. The discussion of Issues 3-6 is also incorporated herein by reference .

Applicant also requested a meaningful translation of DE '365 in respect to this rejection, and none was forthcoming. . It is not possible for Applicant or the Board to tell from the brief information given in English what this reference teaches, for example about the type and orientation of the machining as related to the manner of holding the workpiece.

Claim 11 recites in part:

"affixing the composite material workpiece to the backing fixture with an adhesive material;"

As far as Applicant can tell, none of the references teaches affixing a composite material to a backing fixture, and none of the references teaches affixing a composite material to a backing fixture with an adhesive material. DE '365 has no such teaching in the disjointed English words, and the Examiner never furnished a translation of this reference.

Claim 11 further recites in part:

> "selecting a milling cutter having an effective cutter size less than the hole size"
>
> "advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole, the step of advancing including the step of controlling the rate of longitudinal

advance such that the hole has a substantially constant depth over its entire area as it is cut".

The explanation of the rejection (final Office Action, page 11, lines 11-13) admits that the two Eriksson references are silent on the "substantially constant depth" limitation of claim 11. The explanation of the rejection seeks to create a teaching of this limitation from Handbook. As noted above, Handbook has no discussion, in any way or form, of composite materials or of the machining of composite materials, or of the cutting of holes in composite materials. The discussion of Handbook found in the paragraph bridging pages 11-12 of the final Office Action goes on about the teachings of Handbook, but there is no identification of a location of any teaching of the "substantially constant depth" limitation. The best that the explanation of the rejection can do is to point to an asserted teaching of "various feed rates to try with various materials", but fails to mention that all of the "various materials" are metals, and none of those "various materials" is a composite material. The teachings of this portion of Handbook are limited to metals only. The explanation of the rejection then attempts to build this lack of teaching of the claim limitation into more than it is, by creating a fictitious extension to a composite material. And, keep in mind, that even if one accepts the argument, it still does not teach "substantially constant depth" in the context where the milling cutter has "an effective cutter size less than the hole size"

Eriksson '252 uses a simultaneous axial and radial machining, see col. 5, lines 13-15, but has no teaching of how these movements are coordinated.

Eriksson '281 has a disclosure similar to that of Eriksson '252 in relevant aspects, except that it clearly teaches the use of a hole that does not have a flat bottom, see Figure 16 and the associated discussion.

Each Eriksson patent explicitly teaches "simultaneous machining the workpiece in both an axial and a radial direction..." (Eriksson '252 at col. 5, line 13 and Eriksson ' 281 at col. 8, lines 65-66. This is not a teaching that the hole is or could be of constant depth.

The explanation of the rejection asserts that each of the applied references teaches "orbital machining of a blind hole in a composite material", making reference

to portions of the teachings of the Eriksson inventions. Eriksson never uses the term "orbital machining" to refer to his own invention. The only mention of "orbital machining" in these references occurs in a discussion of a prior art Swedish patent, see col. 2, line 48 of '252 and col. 3, line 1 of '281. This is an important point, because a conclusion of "orbital machining" has significant consequences that are not taught in either Eriksson reference. Any assertion of "orbital machining" in relation to Eriksson's teachings is pure Examiner's speculation unsupported in the references.

What is clear in both Eriksson references is that there is no teaching remotely similar to the claim recitation "maintaining the hole substantially flat bottomed as the milling cutter advances" of claim 1. There is only a teaching of simultaneous machining in two directions.

It is presently unknown whether DE '365 has any teachings regarding orbital machining, and the Office Action never sets forth a location where any such teaching is given.

Handbook, as noted earlier, is nonanalogous art that does not have any teachings on point to composite materials or to the machining of a hole that is larger than the cutter size. Handbook deals only with thread milling and lateral milling, but not to hole cutting. The explanation of the rejection is not able to point to any portion of Handbook that teaches "maintaining the hole substantially flat bottomed as the milling cutter advances".

Claim 12 recites in part:

> "providing a ceramic matrix composite material workpiece having a brittle ceramic matrix"

The explanation of the rejection admits that none of the references has any such teaching, see final Office Action at page 11, lines 9-11.

Claim 13 recites in part:

> "providing a silicon carbide/silicon carbide composite material workpiece"

The explanation of the rejection admits that none of the references has any such teaching, see final Office Action at page 11, lines 9-11.

Regarding claims 12-13, the explanation of the rejection does not make any attempt to assert that the claim limitations can be found in the art. Instead, the explanation of the rejection makes and relies upon the incredible statement, "Applicant has not ascribed any particular criticality to the use of a 'ceramic matrix composite..." Applicant certainly did so. Applicant notes in paragraph [0021] of the Specification, "The composite material workpiece may be of any operable type, but it is preferably a ceramic-matrix composite material wherein the matrix 44 is a nonmetallic, nonorganic, ceramic phase. The brittle ceramic matrix 44 of such composite materials is highly susceptible to damage and failure by splintering, fraying, and/or cracking when conventional hole-drilling techniques are used." While composite materials pose difficult hole-forming problems, the ceramic-matrix composite material poses the greatest difficulty because of its brittle matrix. The present approach provides the solution for this difficult problem. Handbook, for example, does not even deal with this problem. The references have no teaching of the limitations of claims 12-13.

The attempt at rationalizing this limitation is then argued to be based in "design choice". The concept of "matter of obvious design choice" is not intended to substitute for statutory prior art. It provides a means by which one of several realistic alternatives presented by statutory prior art may be selected, absent surprising or unexpected advantages. It is to be used only where the applied statutory prior art sets forth a list of realistic alternative selections, and it would be a matter of design choice to select one member from the list. In this case, the prior art of record presents no such design choice, and accordingly the application of "obvious matter of design choice" is not appropriate here.

Claim 14 recites in part:

> "providing the backing fixture having a shape conformed to the back face of the composite material workpiece"

This claim is rejected under this ground, but its limitations are not mentioned in the explanation of the rejection. None of the references has any such teaching, nor

does any of the references point out any reason to even be concerned with this type of a structure or arrangement.

Issue 8. Are claims 11-14, 17, and 19 properly rejected under 35 USC over any of Thelin '847, Thelin '755, Eriksson '252, Taquist '674, or WO 94/17944, in view of DE '365 and in view of Handbook?

The statement of the rejection cannot be understood, as it is unclear whether the rejection seeks to combine exactly one or more than one of Thelin US Patent 5,934,847, Thelin US Patent 5,816,755, Taquist US Patent 5,685,674, Eriksson US Patent 5,641,252, and WO 94/17944, in combination with DE '365 and in combination with Handbook. The explanation of the rejection gives no clues as to how the rejection is to be constructed from the six references. Applicant will do its best to respond.

Further, the substance of the rejection cannot be understood, inasmuch as the relied-upon teachings of DE '365 are not set forth in a translation of the reference. There is reliance on some English-language partial narrative description, which may not set forth the substance of DE '365. No effective date as a reference of the partial narrative description is provided, so Applicant does not know if the partial narrative description is an effective reference.

Applicant incorporates its prior discussion of Issues 3-7. All of the applied references have been discussed previously, and that discussion is incorporated here.

Claim 11 recites in part:

"affixing the composite material workpiece to the backing fixture with an adhesive material;"

As far as Applicant can tell, none of the references teaches affixing a composite material to a backing fixture, and none of the references teaches affixing a composite material to a backing fixture with an adhesive material. DE '365 has no such teaching in the disjointed English words, and the Examiner never furnished a translation of this reference.

Claim 11 further recites in part:

> "selecting a milling cutter having an effective cutter size less than the hole size"
>
> "advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole, the step of advancing including the step of controlling the rate of longitudinal advance such that the hole has a substantially constant depth over its entire area as it is cut".

The explanation of the rejection (final Office Action, page 14, lines 9-11) admits that the five patent references are silent on the "substantially constant depth" limitation of claim 11. The explanation of the rejection seeks to create a teaching of this limitation from Handbook. As noted above, Handbook has no discussion, in any way or form, of composite materials or of the machining of composite materials, or of the cutting of holes in composite materials. The discussion of Handbook found in the paragraph bridging pages 14-15 of the final Office Action goes on about the teachings of Handbook, but there is no identification of a location of any teaching of the "substantially constant depth" limitation. The best that the explanation of the rejection can do is to point to an asserted teaching of "various feed rates to try with various materials", but fails to mention that all of the "various materials" are metals, and none of those "various materials" is a composite material. The teachings of this portion of Handbook are limited to metals only. The explanation of the rejection then attempts to build this lack of teaching of the claim limitation into more than it is, by creating a fictitious extension to a composite material. And, keep in mind, that even if one accepts the argument, it still does not teach "substantially constant depth" in the context where the milling cutter has "an effective cutter size less than the hole size"

The attempt to find the limitations in the Handbook fails for several reasons.

First, as noted above, Handbook is nonanalogous art that does not deal with "cutting a hole" or with a "composite material workpiece" at all. Applicant

explained in the Specification why a "composite material workpiece" has its own special problems in regard to hole cutting, and every one of the five patent references agrees with Applicant. The Examiner has not shown that the Handbook addresses problems or has any relevant teachings to the present problem of hole cutting in composite materials, or the problems addressed by the five patent references, at all.

Second, the explanation of the rejection does not point to any location in Handbook that deals with a composite material. Claim 1 recites in part: "providing the composite material workpiece". Handbook does not have any teaching about a composite material workpiece.

Third, the explanation of the rejection never is able to point to a location in Handbook where Handbook has any teaching about a situation of "the milling cutter having an effective cutter size less than the hole size", as recited in claim 1. Handbook is concerned with the simple problem of milling a workpiece by lateral movement of the milling cutter (see Fig. 10-78). That is a completely different problem than drilling an oversize hole. The explanation of the rejection argues that simple lateral milling makes obvious the claim limitation "maintaining the hole substantially flat bottomed as the milling cutter advances", when of course Handbook has nothing to do with the type of problem that the claim addresses, where the size of the cutter is less than the hole size. The discussion of Handbook's alleged teachings found at page 5, lines 8-17 of the final Office Action is at attempt to draw general inferences about a completely different problem and completely different material from an unrelated reference. Handbook does not discuss the cutting of holes at all. In Handbook, there is no hole to remain substantially flat-bottomed, because the milling cutter is simply moved laterally in the referenced portion of Chapter 10.

Fourth, for all of the argument, there is never any showing of a teaching in any of the references of the limitation "substantially constant depth" from claim 11.

Fifth, the discussion at page 12-114 of Handbook deals with thread milling and has no relation at all to hole drilling, even though this page is a central basis of the rejection. Applicant still cannot figure out any relevance of Chapter 12 of Handbook, dealing with thread milling, might be, and there is no explanation in the final Office Action.

The five patent references each discloses an approach for producing a hole in a composite material that is admittedly different from the present approach. Otherwise,

the rejection would have been a sec. 102 rejection, an approach attempted in the first Office Action and now withdrawn.

The five patent references are interesting in that they do not teach the present approach, and in most cases teach directly away from the present approach.

Thelin '847 and Thelin '755 each teaches directly away from the present approach, by teaching that the through-hole is drilled first, and then the cutter is inserted and moved laterally, see Figures 2A-B.

Taquist '647 teaches creating a hole through the composite material, then producing an eccentric motion that laterally enlarges the hole, see col. 2, lines 56-63.

Eriksson '252 uses a simultaneous axial and radial machining, see col. 5, lines 13-15, but has no teaching of how these movements are coordinated.

WO '944 describes an apparatus that allows the drilling of holes in a piece of composite material, but never does say how the hole is drilled. Specifically, there is no teaching regarding whether a through-hole is first drilled, as in Thelin '847, Thelin '755, and Taquist '647, or whether some other technique is used.

The explanation of the rejection does not address these specific teachings of the five patent references. That is, the explanation of the rejection does not indicate that three of the references (Thelin '847, Thelin '755, and Taquist '647) teach directly away from the present approach, Eriksson '252 is silent on its approach, and WO '944 teaches only the hole-cutting machine structure with no teaching about how the machine is actually used to cut a hole.

Claim 12 recites in part:

"providing a ceramic matrix composite material workpiece"

Claim 13 recites in part:

"providing a silicon carbide/silicon carbide composite material workpiece"

Neither reference has any such teaching. Regarding claims 12-13, the explanation of the rejection makes the incredible statement, "Applicant has not ascribed any particular criticality to the use of a 'ceramic matrix composite..." Applicant certainly did so. Applicant notes in paragraph [0021] of the Specification,

"The composite material workpiece may be of any operable type, but it is preferably a ceramic-matrix composite material wherein the matrix 44 is a nonmetallic, nonorganic, ceramic phase. The brittle ceramic matrix 44 of such composite materials is highly susceptible to damage and failure by splintering, fraying, and/or cracking when conventional hole-drilling techniques are used." While composite materials pose difficult hole-forming problems, the ceramic-matrix composite material poses the greatest difficulty because of its brittle matrix. The present approach provides the solution for this difficult problem. Handbook, for example, does not even deal with this problem. The references have no teaching of the limitations of claims 12-13.

The attempt at rationalizing this limitation is then argued to be based in "design choice". The concept of "matter of obvious design choice" is not intended to substitute for statutory prior art. It provides a means by which one of several realistic alternatives presented by statutory prior art may be selected, absent surprising or unexpected advantages. It is to be used only where the applied statutory prior art sets forth a list of realistic alternative selections, and it would be a matter of design choice to select one member from the list. In this case, the prior art of record presents no such design choice, and accordingly the application of "obvious matter of design choice" is not appropriate here.

Claim 14 recites in part:

> "providing the backing fixture having a shape conformed to the back face of the composite material workpiece"

This claim is rejected under this ground, but its limitations are not mentioned in the explanation of the rejection. None of the references has any such teaching, nor does any of the references point out any reason to even be concerned with this type of a structure or arrangement.

Claim 19 recites in part:

> "advancing the milling cutter longitudinally into the composite material workpiece by at least a thickness of the composite material workpiece, thereby forming a through hole".

None of the references has any such teaching, and most teach away from this limitation, while the others are silent.

Issue 9. Are claims 11-17 and 19 properly rejected under 35 USC 103 over WO '944 in view of Constantine '249 and in view of Handbook?

Applicant incorporates the prior discussion of Issues 3-8. All of the references have been discussed previously, and that discussion is incorporated here.

Claim 11 recites in part:

> "selecting a milling cutter having an effective cutter size less than the hole size"
>
> "advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole, the step of advancing including the step of controlling the rate of longitudinal advance such that the hole has a substantially constant depth over its entire area as it is cut".

The explanation of the rejection (final Office Action, page 16, last three lines on page) admits that WO '944 is silent on the "substantially constant depth" limitation of claim 11. The explanation of the rejection seeks to create a teaching of this limitation from Handbook. As noted above, Handbook has no discussion, in any way or form, of composite materials or of the machining of composite materials, or of the cutting of holes in composite materials. The discussion of Handbook found in the second full paragraph of page 17 of the final Office Action goes on about the teachings of Handbook, but there is no identification of a location of any teaching of the "substantially constant depth" limitation. The best that the explanation of the rejection can do is to point to an asserted teaching of "various feed rates to try with

various materials", but fails to mention that all of the "various materials" are metals, and none of those "various materials" is a composite material. The teachings of this portion of Handbook are limited to metals only. The explanation of the rejection then attempts to build this lack of teaching of the claim limitation into more than it is, by creating a fictitious extension to a composite material. And, keep in mind, that even if one accepts the argument, it still does not teach "substantially constant depth" in the context where the milling cutter has "an effective cutter size less than the hole size"

The attempt to find the limitations in the Handbook fails for several reasons.

First, as noted above, Handbook is nonanalogous art that does not deal with "cutting a hole" or with a "composite material workpiece" at all. Applicant explained in the Specification why a "composite material workpiece" has its own special problems in regard to hole cutting, and every one of the five patent references agrees with Applicant. The Examiner has not shown that the Handbook addresses problems or has any relevant teachings to the present problem of hole cutting in composite materials, or the problems addressed by the five patent references, at all.

Second, the explanation of the rejection does not point to any location in Handbook that deals with a composite material. Claim 1 recites in part: "providing the composite material workpiece". Handbook does not have any teaching about a composite material workpiece.

Third, the explanation of the rejection never is able to point to a location in Handbook where Handbook has any teaching about a situation of "the milling cutter having an effective cutter size less than the hole size", as recited in claim 1. Handbook is concerned with the simple problem of milling a workpiece by lateral movement of the milling cutter (see Fig. 10-78). That is a completely different problem than drilling an oversize hole. The explanation of the rejection argues that simple lateral milling makes obvious the claim limitation "maintaining the hole substantially flat bottomed as the milling cutter advances", when of course Handbook has nothing to do with the type of problem that the claim addresses, where the size of the cutter is less than the hole size. The discussion of Handbook's alleged teachings found at page 5, lines 8-17 of the final Office Action is at attempt to draw general inferences about a completely different problem and completely different material from an unrelated reference. Handbook does not discuss the cutting of holes at all. In

Handbook, there is no hole to remain substantially flat-bottomed, because the milling cutter is simply moved laterally in the referenced portion of Chapter 10.

Fourth, for all of the argument, there is never any showing of a teaching in any of the references of the limitation "substantially constant depth" from claim 11.

Fifth, the discussion at page 12-114 of Handbook deals with thread milling and has no relation at all to hole drilling, even though this page is a central basis of the rejection. Applicant still cannot figure out any relevance of Chapter 12 of Handbook, dealing with thread milling, might be, and there is no explanation in the final Office Action.

Claim 12 recites in part:

"providing a ceramic matrix composite material workpiece"

Claim 13 recites in part:

"providing a silicon carbide/silicon carbide composite material workpiece"

Neither reference has any such teaching. Regarding claims 12-13, the explanation of the rejection makes the incredible statement, "Applicant has not ascribed any particular criticality to the use of a 'ceramic matrix composite..." Applicant certainly did so. Applicant notes in paragraph [0021] of the Specification, "The composite material workpiece may be of any operable type, but it is preferably a ceramic-matrix composite material wherein the matrix 44 is a nonmetallic, nonorganic, ceramic phase. The brittle ceramic matrix 44 of such composite materials is highly susceptible to damage and failure by splintering, fraying, and/or cracking when conventional hole-drilling techniques are used." While composite materials pose difficult hole-forming problems, the ceramic-matrix composite material poses the greatest difficulty because of its brittle matrix. The present approach provides the solution for this difficult problem. Handbook, for example, does not even deal with this problem. The references have no teaching of the limitations of claims 12-13.

The attempt at rationalizing this limitation is then argued to be based in "design choice". The concept of "matter of obvious design choice" is not intended to

substitute for statutory prior art. It provides a means by which one of several realistic alternatives presented by statutory prior art may be selected, absent surprising or unexpected advantages. It is to be used only where the applied statutory prior art sets forth a list of realistic alternative selections, and it would be a matter of design choice to select one member from the list. In this case, the prior art of record presents no such design choice, and accordingly the application of "obvious matter of design choice" is not appropriate here.

Claim 14 recites in part:

> "providing the backing fixture having a shape conformed to the back face of the composite material workpiece"

This claim is rejected under this ground, but its limitations are not mentioned in the explanation of the rejection. None of the references has any such teaching, nor does any of the references point out any reason to even be concerned with this type of a structure or arrangement.

Claim 19 recites in part:

> "advancing the milling cutter longitudinally into the composite material workpiece by at least a thickness of the composite material workpiece, thereby forming a through hole".

None of the references has any such teaching, and most teach away from this limitation, while the others are silent.

Issue 10. Is claim 20 properly rejected under 35 USC 103 over any of Thelin '847, Thelin '755, Taquist '674, Eriksson '252, or WO 94/17944, or Eriksson '281 in view of DE '365?

This statement of the rejection is incomprehensible, despite requests from applicant for a proper statement of the rejection. Does this statement attempt to formulate a rejection over (1) one or more than one of Thelin '847, Thelin '755, Taquist '674, Eriksson '252, or WO 94/17944, or (2) Eriksson '281 in view of DE

'365. Or is the statement a rejection over (1) one or more than one of Thelin '847, Thelin '755, Taquist '674, Eriksson '252, or (2) WO 94/17944 or Eriksson '281 in view of DE '365. Or is the statement a rejection of (1) one or more than Thelin '847, Thelin '755, Taquist '674, Eriksson '252, or (2) WO 94/17944, or (3) Eriksson '281 in view of DE '365? Or is it something else?

Further, the substance of the rejection cannot be understood, inasmuch as the relied-upon teachings of DE '365 are not set forth in a translation of the reference. There is reliance on some English-language partial narrative description, which may not set forth the substance of DE '365. No effective date as a reference of the partial narrative description is provided, so Applicant does not know if the partial narrative description is an effective reference.

Claim 20 recites in part:

> "providing a ceramic-matrix composite material workpiece having fibers embedded in a brittle ceramic matrix"

The explanation of the rejection admits, at page 19, lines 15-17, that the references do not teach this limitation.

The explanation of the rejection does not make any attempt to assert that the claim limitations can be found in the art. Instead, the explanation of the rejection makes and relies upon the incredible statement, "Applicant has not ascribed any particular criticality to the use of a 'ceramic matrix composite..." (second full paragraph on page 20 of the final Office Action) Applicant certainly did so. Applicant notes in paragraph [0021] of the Specification, "The composite material workpiece may be of any operable type, but it is preferably a ceramic-matrix composite material wherein the matrix 44 is a nonmetallic, nonorganic, ceramic phase. The brittle ceramic matrix 44 of such composite materials is highly susceptible to damage and failure by splintering, fraying, and/or cracking when conventional hole-drilling techniques are used." While composite materials pose difficult hole-forming problems, the ceramic-matrix composite material poses the greatest difficulty because of its brittle matrix. The present approach provides the solution for this difficult problem. Handbook, for example, does not even deal with this problem. The references have no teaching of the limitations of claim 20.

The attempt at rationalizing this limitation is then argued to be based in "design choice". The concept of "matter of obvious design choice" is not intended to substitute for statutory prior art. It provides a means by which one of several realistic alternatives presented by statutory prior art may be selected, absent surprising or unexpected advantages. It is to be used only where the applied statutory prior art sets forth a list of realistic alternative selections, and it would be a matter of design choice to select one member from the list. In this case, the prior art of record presents no such design choice, and accordingly the application of "obvious matter of design choice" is not appropriate here.

Claim 20 further recites in part:

> "providing a ceramic-matrix composite material workpiece having fibers embedded in a brittle ceramic matrix;
>
> selecting a milling cutter having an effective cutter size less than the hole size"

The references have no such teaching of selecting such a milling cutter in the context of producing a hole in a ceramic-matrix composite material workpiece having fibers embedded in a brittle ceramic matrix. Because such a milling cutter may be used in another context teaches nothing about its use in the context of the brittle ceramic-matrix composite material, which has its own distinctive material properties.

Claim 20 further recites in part:

> "providing a ceramic-matrix composite material workpiece having fibers embedded in a brittle ceramic matrix;
>
> selecting a milling cutter having an effective cutter size less than the hole size;
>
> mounting the composite material workpiece in operable relation to the milling cutter wherein the step of mounting includes the steps of
>
> providing a backing fixture, and
>
> affixing a back face of the composite material workpiece to the backing fixture;"

The references have no such teaching of selecting such a milling cutter and mounting the composite material workpiece in the described manner, in the context of producing a hole in a ceramic-matrix composite material workpiece having fibers embedded in a brittle ceramic matrix. Because such a milling cutter and backing fixture may be used in another context teaches nothing about its use in the context of the brittle ceramic-matrix composite material, which has its own distinctive material properties.

DE '365 is relied upon for the teaching of the backing fixture, but this reference has not been provided in translated form so that its actual teachings may be known. See the prior discussion.

Claim 20 further recites in part:

> "advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance from a front face of the composite material workpiece toward the back face, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole."

None of the references has any such teaching. The explanation of the rejection asserts that "Each of '847, '755, Taquist et al., '252, '944, and '281 teaches orbital machining of a hole in a composite material..." That statement is simply not true. The relied upon portions of each reference do not support this statement. See the prior discussion of each reference for more detail.

Issue 11. Is claim 21 properly rejected under 35 USC 103 over any of Thelin '847, Thelin '755, Eriksson '252, Taquist '674, Eriksson '252, or WO 94/17944, or Eriksson '281 in view of DE '365, and further in view of Handbook?

This statement of the rejection is incomprehensible, despite requests from applicant for a proper statement of the rejection. Does this statement of a rejection attempt to formulate a rejection over (1) Thelin '847, Thelin '755, Eriksson '252, Taquist '674, Eriksson '252, or WO 94/17944, or (2) Eriksson '281 in view of DE

'365, and further in view of Handbook. Or is the statement a rejection over (1) Thelin '847, Thelin '755, Eriksson '252, Taquist '674, Eriksson '252, or (2) WO 94/17944, or Eriksson '281 in view of DE '365, and further in view of Handbook. Or is the statement a rejection over (1) Thelin '847, Thelin '755, Eriksson '252, Taquist '674, Eriksson '252, in view of Handbook, or (2) WO 94/17944 or Eriksson '281 in view of DE '365, and further in view of Handbook. Or is it something else?

Further, the substance of the rejection cannot be understood, inasmuch as the relied-upon teachings of DE '365 are not set forth in a translation of the reference. There is reliance on some English-language partial narrative description, which may not set forth the substance of DE '365. No effective date as a reference of the partial narrative description is provided, so Applicant does not know if the partial narrative description is an effective reference.

These references have been discussed previously, and that discussion is incorporated here. The discussion of Issues 3-10 is incorporated here.

Claim 21 depends from claim 20. The combination of references does not teach the limitations of claim 20 for the reasons stated above in respect to Issue 10. The addition of Handbook clearly does not teach result in a teaching of the limitations of claim 20, inasmuch as Handbook has no teachings about composite materials, machining of holes, or machining of composite materials.

Additionally, claim 21 recites in part:

> "maintaining the hole substantially flat-bottomed as the milling cutter advances".

The explanation of the rejection admits that none of the references teaches this limitation, see page 21, lines 5-8 of the final Office Action. The explanation of the rejection seeks to create a teaching of this limitation from Handbook (final Office Action, page 21, second full paragraph). As noted above, Handbook has no discussion, in any way or form, of composite materials or of the machining of composite materials, or of the cutting of holes in composite materials. The discussion of Handbook found in the third full paragraph of page 21 of the final Office Action

goes on about the teachings of Handbook, but there is no identification of a location of any teaching of the "substantially constant depth" limitation. The best that the explanation of the rejection can do is to point to an asserted teaching of "various feed rates to try with various materials", but fails to mention that all of the "various materials" are metals, and none of those "various materials" is a composite material. The teachings of this portion of Handbook are limited to metals only. The explanation of the rejection then attempts to build this lack of teaching of the claim limitation into more than it is, by creating a fictitious extension to a composite material. And, keep in mind, that even if one accepts the argument, it still does not teach "substantially constant depth" in the context where the milling cutter has "an effective cutter size less than the hole size"

The attempt to find the limitations in the Handbook fails for several reasons.

First, as noted above, Handbook is nonanalogous art that does not deal with "cutting a hole" or with a "composite material workpiece" at all. Applicant explained in the Specification why a "composite material workpiece" has its own special problems in regard to hole cutting, and every one of the five patent references agrees with Applicant. The Examiner has not shown that the Handbook addresses problems or has any relevant teachings to the present problem of hole cutting in composite materials, or the problems addressed by the five patent references, at all.

Second, the explanation of the rejection does not point to any location in Handbook that deals with a composite material. Claim 1 recites in part: "providing the composite material workpiece". Handbook does not have any teaching about a composite material workpiece.

Third, the explanation of the rejection never is able to point to a location in Handbook where Handbook has any teaching about a situation of "the milling cutter having an effective cutter size less than the hole size", as recited in claim 1. Handbook is concerned with the simple problem of milling a workpiece by lateral movement of the milling cutter (see Fig. 10-78). That is a completely different problem than drilling an oversize hole. The explanation of the rejection argues that simple lateral milling makes obvious the claim limitation "maintaining the hole substantially flat bottomed as the milling cutter advances", when of course Handbook has nothing to do with the type of problem that the claim addresses, where the size of the cutter is less than the hole size. The discussion of Handbook's alleged teachings

found at page 5, lines 8-17 of the final Office Action is at attempt to draw general inferences about a completely different problem and completely different material from an unrelated reference. Handbook does not discuss the cutting of holes at all. In Handbook, there is no hole to remain substantially flat-bottomed, because the milling cutter is simply moved laterally in the referenced portion of Chapter 10.

Fourth, for all of the argument, there is never any showing of a teaching in any of the references of the limitation "substantially constant depth" from claim 11.

Fifth, the discussion at page 12-114 of Handbook deals with thread milling and has no relation at all to hole drilling, even though this page is a central basis of the rejection. Applicant still cannot figure out any relevance of Chapter 12 of Handbook, dealing with thread milling, might be, and there is no explanation in the final Office Action.

SUMMARY AND CONCLUSION

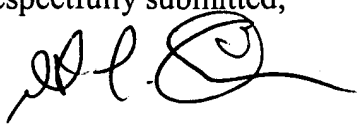
The invention is easily recited in relatively short claims. Claim 1, for example, has 12 lines. Yet a minimum of three, and as many as seven, references are combined together in each of the nine art rejections in an attempt to make the inventions recited in the claims "obvious". There is no objective basis stated for combining the teachings of the multiple references. Even in these circumstances, the attempt to perform the hindsight reconstruction of the claimed invention is not successful, for the reasons discussed above.

Absent any good prior art rejection, two sec. 112 rejections are asserted to create confusion about clearly stated claim recitations. "Substantially flat" referring to the bottom of a hole was explained in full detail in the Specification, so that a person who works in the field of machining holes into composite materials can understand the limits of the claimed invention. As of a year ago when Applicant did a search, "substantially flat" had appeared in the claim recitations of 22,922 patents since 1975, indicating that both those skilled in various arts and most patent examiners know exactly what the term means. There is no uncertainty about this term.

Applicant asks that the Board reverse the rejections and allow this application to issue.

Dated: October 26, 2004

Respectfully submitted,



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CLAIMS APPENDIX

Clean Copy of Appealed Claims

1. A method for cutting a hole of a hole size in a composite material workpiece, the method comprising the steps of:

providing the composite material workpiece;

selecting a milling cutter having an effective cutter size less than the hole size;

mounting the composite material workpiece in operable relation to the milling cutter;

rotating the milling cutter about an axis of rotation; and

advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole, and while maintaining the hole substantially flat bottomed as the milling cutter advances.

2. The method of claim 1, wherein the step of providing includes the step of

providing a ceramic matrix composite material workpiece.

3. The method of claim 1, wherein the step of providing includes the step of

providing a silicon carbide/silicon carbide composite material workpiece.

4. The method of claim 1, wherein the step of mounting includes the steps of

providing a backing fixture, and

affixing the composite material workpiece to the backing fixture with an adhesive material.

5. The method of claim 4, wherein the step of affixing includes the step of

affixing the composite material workpiece to the backing fixture with a thermoplastic adhesive material.

6. The method of claim 4, including an additional step, after the step of advancing, of

removing the composite material workpiece from the backing fixture.

7. The method of claim 1, wherein the step of advancing includes the step of

controlling the rate of longitudinal advance such that the hole remains substantially flat-bottomed as it is cut.

8. The method of claim 1, wherein the hole is cylindrical with a hole diameter, and wherein the step of selecting includes the step of

selecting the miller cutter to be cylindrical with an effective cutter diameter less than the hole diameter.

9. The method of claim 1, wherein the step of advancing includes the step of

advancing the milling cutter longitudinally into the composite material workpiece less than a thickness of the composite material workpiece, thereby forming a blind hole.

10. The method of claim 1, wherein the step of advancing includes the step of

advancing the milling cutter longitudinally into the composite material workpiece by at least a thickness of the composite material workpiece, thereby forming a through hole.

11. A method for cutting a hole of a hole size in a composite material workpiece, the method comprising the steps of:

providing the composite material workpiece;

selecting a milling cutter having an effective cutter size less than the hole size;

mounting the composite material workpiece in operable relation to the milling cutter wherein the step of mounting includes the steps of

providing a backing fixture, and

affixing the composite material workpiece to the backing fixture with an adhesive material;

rotating the milling cutter about an axis of rotation;

advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole, the step of advancing including the step of controlling the rate of longitudinal advance such that the hole has a substantially constant depth over its entire area as it is cut; and, after the hole is completed,

removing the composite material workpiece from the backing fixture.

12. The method of claim 11, wherein the step of providing includes the step of

providing a ceramic matrix composite material workpiece having a brittle ceramic matrix.

13. The method of claim 11, wherein the step of providing includes the step of

providing a silicon carbide/silicon carbide composite material workpiece.

14. The method of claim 11, wherein the composite material workpiece has a front face to which the milling cutter is first contacted and an oppositely disposed back face, and wherein the step of providing the backing fixture includes the step of

providing the backing fixture having a shape conformed to the back face of the composite material workpiece.

15. The method of claim 14, wherein the step of providing the backing fixture includes the step of

providing a nonplanar backing fixture.

16. The method of claim 11, wherein the step of affixing includes the step of

affixing the composite material workpiece to the backing fixture with a thermoplastic adhesive material.

17. The method of claim 11, wherein the hole is cylindrical with a hole diameter, and wherein the step of selecting includes the step of

selecting the miller cutter to be cylindrical with an effective cutter diameter less than the hole diameter.

18. The method of claim 11, wherein the step of advancing includes the step of

advancing the milling cutter longitudinally into the composite material workpiece less than a thickness of the composite material workpiece, thereby forming a blind hole.

19. The method of claim 11, wherein the step of advancing includes the step of

advancing the milling cutter longitudinally into the composite material workpiece by at least a thickness of the composite material workpiece, thereby forming a through hole.

20. A method for cutting a hole of a hole size in a composite material workpiece, the method comprising the steps of:

providing a ceramic-matrix composite material workpiece having fibers embedded in a brittle ceramic matrix;

selecting a milling cutter having an effective cutter size less than the hole size;

mounting the composite material workpiece in operable relation to the milling cutter wherein the step of mounting includes the steps of

providing a backing fixture, and

affixing a back face of the composite material workpiece to the backing fixture;

rotating the milling cutter about an axis of rotation; and

advancing the milling cutter longitudinally into the composite material workpiece parallel to the axis of rotation at a rate of longitudinal advance from a front

face of the composite material workpiece toward the back face, while laterally moving the milling cutter perpendicular to the axis of rotation to interpolate the hole.

21. The method of claim 21, wherein the step of advancing includes the step of

maintaining the hole substantially flat-bottomed as the milling cutter advances.